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## EQUUS BEDS GROUNDWATER MANAGEMENT DISTRICT NO. 2

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December 14, 2016

Alan King, Director of Public Works & Utilities  
City of Wichita  
455 N. Main, Eighth Floor  
Wichita, Kansas 67202-1606

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Re: ASR Drought Modeling Review

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Dear Mr. King:

Thank you for the opportunity to review the Equus Beds Wellfield (EBWF) drought scenario modeling results demonstrating the City of Wichita (City) groundwater pumping options during a modeled one percent drought covering a span of eight consecutive years. The Equus Beds Groundwater Management District No. 2 (District) received the City's letter dated November 15, 2016, including the modeled results in graphic form, on November 18, 2016. The City requested a written response from the District regarding the model results by December 15, 2016.

Since November 18, 2016, District staff, in cooperation with City of Wichita staff, spent a considerable amount of time reviewing the model inputs and results. During the review, many needed revisions were identified by both the City staff and the District staff. The two parties worked together to make needed corrections and re-run the model during the review. In addition, District staff was able to incorporate the City's model inputs into the District's modeling software (Groundwater Modeling System), which enabled the model inputs and outputs to be viewed, evaluated, manipulated and revised. To date, a tremendous amount of time and effort by the District staff and City staff has been put forth in an effort to ensure the model inputs and results are accurate.

At the December 13, 2016, Board of Directors' meeting, the District Board of Directors reviewed a District staff summary of the November 15, 2016, model results, ensuing review process, and additional needed model revisions and model information. A copy of the PowerPoint slides from the presentation is enclosed for your information. Upon review of the information presented and discussed at the meeting, it was the decision of the Board to notify the City of Wichita that the modeled results are unacceptable at this time for evaluating a modified Minimum Index Level for the City's Aquifer Storage and Recovery Project (ASR). The District Board requests that the City provide model information and update the model as noted below:

- Conduct quality control before re-submitting the model.
- Correct the recharge through time, as recharge trends in the model do not follow actual precipitation trends.
- Calibrate the model or use an existing calibrated model.
- Investigate pumping versus time and ensure that the same potential error with recharge is not present in other model inputs.
- Investigate all other model parameters through time for accuracy.
- Demonstrate that Cheney Reservoir has the capacity throughout an eight year drought to sustain the quantities indicated in the model inputs (Attachment A of the original model results).

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- Make starting water levels accurate, as starting heads in the sand hills are inaccurate. At a minimum, modify the starting heads in the sand hills region to conform to the lower portion of the aquifer to be consistent with the rest of the model.
- Provide written explanation and justification for model inputs, especially the drought scenario.
- Model two years of recovery following the drought.
- Compare modeled results.

Please note that there is no deadline for the City to provide the requested model updates and model information to the District and the District advises to take whatever time the City needs. Additionally, the District Board requests that upon receiving the updated model and model information listed above, that the District staff be allowed a minimum of thirty (30) days to review the updated model and information before the Board of Directors reviews the model results and provides a documented response.

The District looks forward to continuing to work collaboratively with the City on this important modeling effort. Please contact the District if you have any questions or need additional information.

Sincerely,  
EQUUS BEDS GROUNDWATER  
MANAGEMENT DISTRICT NO. 2



Tim Boese  
Manager

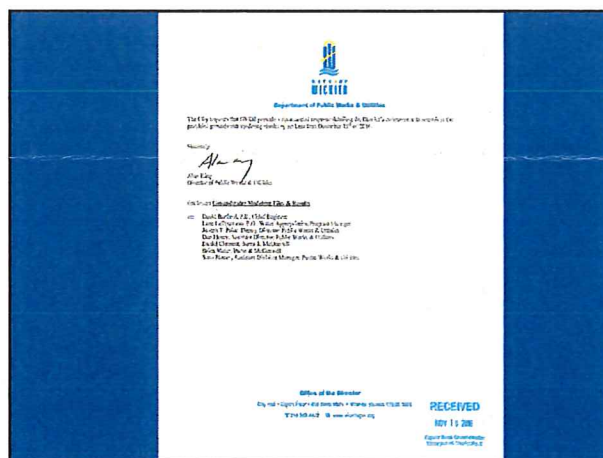
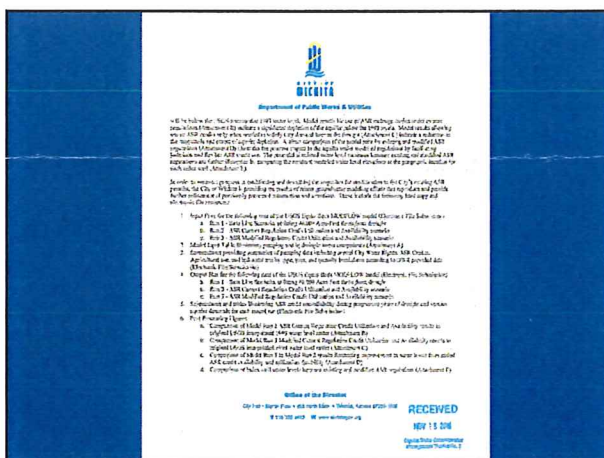
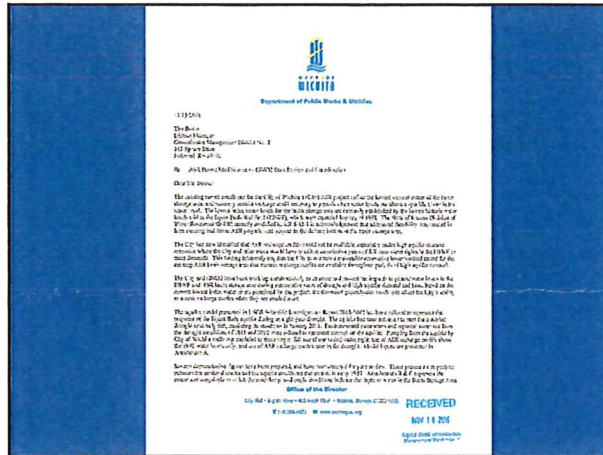
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Enclosure

pc: David Barfield, Division of Water Resources  
Lane Letourneau, Division of Water Resources  
Joseph Pajor, City of Wichita Public Works & Utilities  
Don Henry, City of Wichita Public Works & Utilities  
Daniel Clement, Burns & McDonnell  
Brian Meier, Burns & McDonnell  
Scott Macey, City of Wichita Public Works & Utilities



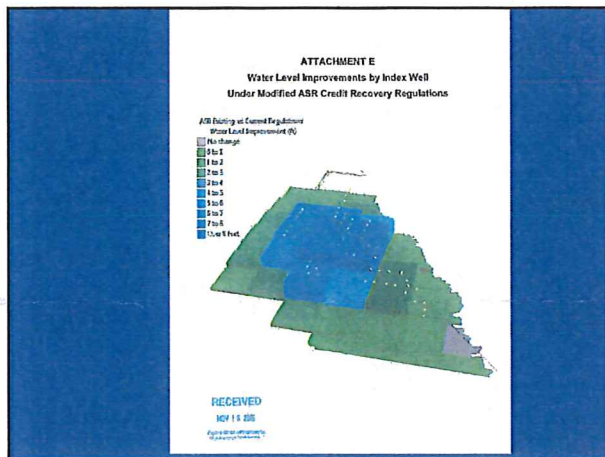
**November 18<sup>th</sup> – At a meeting between GMD2 staff and City of Wichita Staff, a letter and modeling results packet were received from the City outlining that the GMD has until December 15-2016 to provide a documented to the provided modeling results.**

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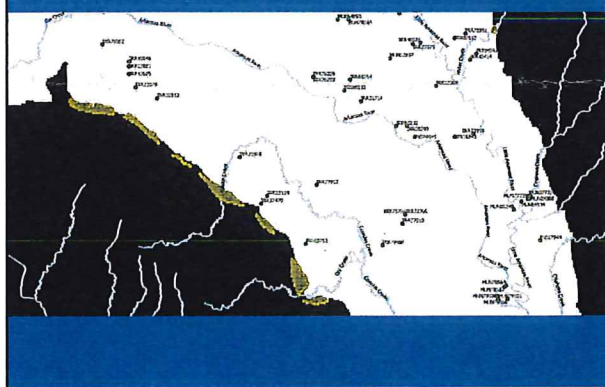


#### TIMELINE OF EVENTS:

November 18<sup>th</sup> – During the meeting with City of Wichita Staff, District staff incorporated the model into the District's GMS modeling software and discovered errors.

November 21<sup>st</sup> – The City reviewed the errors found on the 18<sup>th</sup> and submitted a revised model for review. The City noted that there were changes in the results and also proposed another meeting on November 23<sup>rd</sup>. Image 1 was submitted showing the areas of concern.

Image 1, yellow dots indicate a point of concern in the model



#### TIMELINE OF EVENTS:

November 22<sup>nd</sup> – David Barfield submitted an email to the City indicating that the following materials would be helpful in the model review:

- Evidence that 2011-2012 repeated 4 times is an appropriate 1% drought scenario;
- more explanation on predicted inflows to Cheney;
- list of years and cells when water levels fall below 1993 levels; and
- 2 years of modeled recovery.

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**TIMELINE OF EVENTS:**

November 23<sup>rd</sup> – Webex meeting – City Staff came to GMD2 office for conference with Burns and McDonnell to review some of the issues found with model inputs.

**TIMELINE OF EVENTS:**

November 23<sup>rd</sup> – The City proposed a meeting on Tuesday the 29<sup>th</sup> to review the most recent modeling efforts in person.

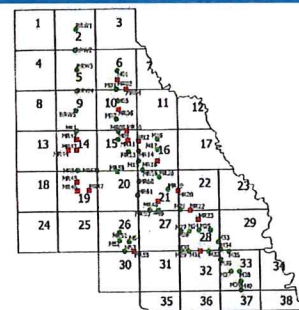
November 28<sup>th</sup> – GMD2 met with City Staff to help them understand how to use GMS and do visual inspection of the model inputs and results.

November 29<sup>th</sup> – The City fixed some previously identified problem areas and noticed some differences and submitted an adjusted model.

**TIMELINE OF EVENTS:**

December 5<sup>th</sup> – The City adjusted well pumping inputs and supplied a new input file with additional graphics on the affect that the changes had. The following Figure 2 highlights wells that changed since the last model run.

Image 2. Red wells quantity limited by GPM



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# **TIMELINE OF EVENTS:**

December 8<sup>th</sup> – GMD2 staff reviewed the model inputs and new model comparison results were sent to GMD2.

Image 3a. Effects of removing cells with errors along western boundary (shallow)

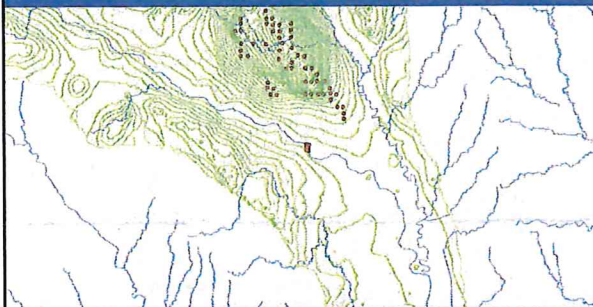
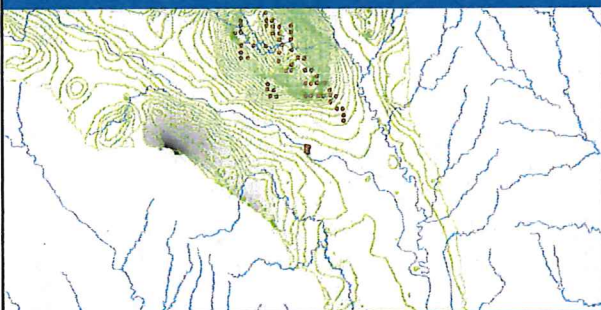


Image 3b. Effects of removing wells with errors along western boundary (deep)



# **TIMELINE OF EVENTS:**

December 8<sup>th</sup> – GMD2 staff found several critical model input errors and other critical points to consider before these model results should be used to determine what, if any, changes should be made to the lower index water level recharge credit withdrawal restriction..

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**REVIEW OF MODELED INPUTS:**

- Model inputs were critically reviewed at each of the meetings listed on the timeline. The City of Wichita and GMD2 staff have been reviewing and correcting model inputs as they became available. After model inputs were agreed upon, the modflow model results were reviewed by GMD2 Staff and additional corrections to the model were made. Corrected and updated materials have been submitted to the GMD for review through December 5<sup>th</sup>, 2016.

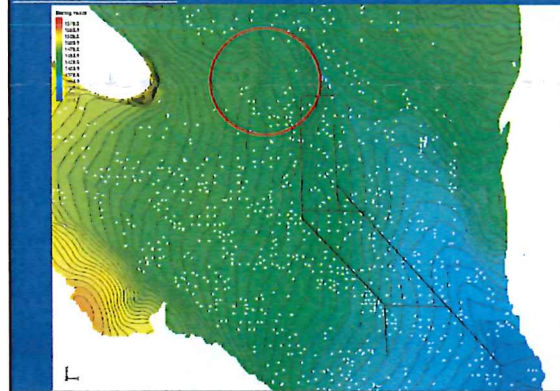
**REVIEW OF MODELED INPUTS:**

- The groundwater model that the City submitted started in [2006] and ran through [2018]
  - 3 years were taken from the calibrated USGS model (2006 to 2008)
  - 10 years were not calibrated (2009 to 2018)
  - 6 years were forecasted (2013 to 2018)

**REVIEW OF MODELED INPUTS:**

- Starting Water Levels
  - Starting water levels in the Sand Hills area are off.
  - Starting water levels in this area were scrutinized during the McPherson BPU application reviews for not representing water levels appropriately.
  - Other entities agree that the sand hills area is difficult to model and needs refinement. The area of concern includes portions of ASR Cell No. 1.
  - see next slide for figure of modeled starting water levels

Starting water levels in model. Red circle indicates area of concern

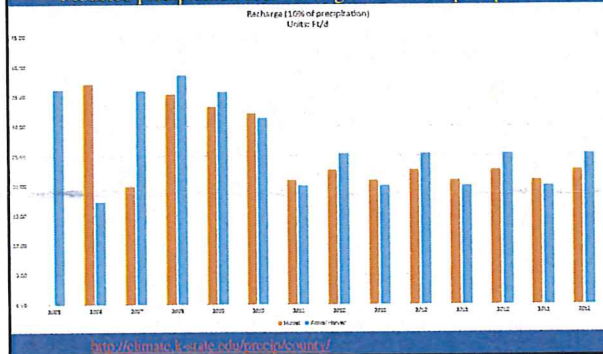




**REVIEW OF MODELED INPUTS:**

- Recharge/Precipitation**

- Modeled precipitation does not align with actual precipitation.

**REVIEW OF MODELED INPUTS**

- Pumping / Other Inputs**

- The assigned pumping from wells was changed since the model receipt on November 18<sup>th</sup>.

- Calibration**

- This model was not calibrated.

- Other Un-Modeled Questions**

- Available water from Cheney reservoir was not validated.

**SUMMARY**

- GMD2 and City of Wichita Staff have worked together to agree on a modeling approach and inputs.
- GMD2 staff was asked on November 18 to provide a review of an incomplete model by December 15<sup>th</sup>
- GMD2 staff and City of Wichita staff have identified errors/issues and updated the model through the review process.
- Reviewing and updating the model multiple times is necessary before a final product is ready for review.
- The model is still being built.

**Recommendations before another review:**

- Conduct quality control before re-submitting the model.
- Correct the recharge through time. Recharge trends in model do not follow actual precipitation trends.
- Calibrate the model or use an existing calibrated model.
- Investigate pumping vs time. Ensure the same potential error with recharge is not present in other parameters.
- Investigate all other parameters through time for accuracy.

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**Recommendations before another review:**

- Demonstrate that Cheney reservoir has the capacity throughout an 8 year drought to sustain the quantities indicated in Attachment A.
- Make starting water levels accurate. Starting heads in the sand hills are off. At a minimum, modify the starting heads in the sand hills region to conform to the lower portion of the aquifer to be consistent with the rest of the model.

**Recommendations before another review:**

- Provide written explanation and justification for model inputs, especially the drought scenario
- Model 2 years of recovery
- Compare modeled results

**Additional Revisions to consider:**

- Consider using actual historically recorded drought data.
- A 1950's and 1930's type drought is closer to a 1% drought than eight years of 2011 and 2012 conditions (Mary Knapp, Personal Correspondence, 2016)
- Update the new modeled period with an actual recorded 8-year-long drought scenario in Kansas.
- Consider running and reviewing alternative pumping strategies.

**Staff Recommendations:**

Notify the City of Wichita that the modeled results are unacceptable at this time for evaluating a modified Minimum Index Level. Request that the City update the model and provide model information as noted in "Recommendations before another review" to the District. Upon receipt, the District will review the model results and provide a recommendation to the Board.

WATER RESOURCES  
DIVISION

KANSAS DEPARTMENT OF AGRICULTURE